

## CLAIMS

1. A multi-joint drive mechanism comprising a bone-member layer member (101) in which a plurality of bone members (1, 1-1, 1-2, 1-3, 1-4) are arranged in arrays, the plurality of bone members being movably coupled at coupling portions (1A, 1B, 2A, 30), and elastically expanding/contracting members (3, 3-1, 3-2, 3-3) which are arranged so as to stretch over the coupling portions on a contact-surface side of the bone-member layer member that makes contact with an object and/or on its noncontact-surface side opposed to the contact-surface side and moreover which are fixed between the plurality of bone members,

wherein the multi-joint drive mechanism drives flexural motions with the coupling portions between the plurality of adjoining bone members serving as joints by expanding or contracting the elastically expanding/contracting member.

2. The multi-joint drive mechanism as claimed in Claim 1, wherein a degree of freedom of the coupling portions is given generally only by a degree of rotational freedom and the degree of freedom of the coupling portions at least of proximities of their forward ends is restrained to one degree of freedom about an axis generally perpendicular to a direction the arrays of the bone-member

layer member.

3. The multi-joint drive mechanism as claimed in Claim 2, wherein the coupling portions are constructed by hinges each formed of a flat spring (2, 30).

5 4. The multi-joint drive mechanism as claimed in Claim 2, wherein the coupling portions (1A, 1B) are hinges formed of the bone members themselves by constricting a part of the bone members.

5. The multi-joint drive mechanism as claimed in 10 Claim 1, wherein a flexible wiring board (7, 40) having signal lines (41) for connection of deformation sensors (8, 42) for detecting deformation amount of the coupling portions, and drive lines for electrically driving the elastically expanding/contracting members is disposed in 15 proximities to flexural portions of the coupling portions.

6. The multi-joint drive mechanism as claimed in Claim 5, wherein the flexible wiring board (40) serves also as hinges (40A) each formed of a flat spring.

7. The multi-joint drive mechanism as claimed in any 20 one of Claims 1 to 6, further comprising a device for expanding or contracting the elastically expanding/contracting member, the device being a device which is driven with air pressure applied to a rubber elastic member or a device which is driven by heating and 25 cooling shape-memory material or a device which is driven

with an electric field applied to electro-active polymer.

8. The multi-joint drive mechanism as claimed in Claim 7, wherein the elastically expanding/contracting member is formed of a rubber elastic member, and the device 5 for expanding or contracting the elastically expanding/contracting member is a device for performing drive by application of air pressure to the rubber elastic member, the multi-joint drive mechanism further comprising a multilayer-type pneumatic piping layer member (60) having 10 piping for applying air pressure to the rubber elastic member.

9. A method for manufacturing a multi-joint drive mechanism which comprises a bone-member layer member (101) in which a plurality of bone members (1, 1-1, 1-2, 1-3, 1- 15 4) are arranged in arrays, the plurality of bone members being movably coupled at coupling portions (1A, 1B, 2A, 30), and elastically expanding/contracting members (3, 3-1, 3-2, 3-3) which are arranged so as to stretch over the coupling portions on a contact-surface side of the bone-member layer 20 member that makes contact with an object and/or on its noncontact-surface side opposed to the contact-surface side and moreover which are fixed between the plurality of bone members, wherein the multi-joint drive mechanism drives flexural motions with the coupling portions between the 25 plurality of adjoining bone members serving as joints by

expanding or contracting the elastically expanding/contracting member, the method comprising:

collectively forming at least the bone-member layer member (101) in which the plurality of bone members  
5 are arranged in a generally planar fashion; and

coupling an elastically expanding/contracting member-layer member (103), with which the plurality of elastically expanding/contracting members are integrated, to an adjoining surface of the bone-member layer member on  
10 the contact-surface side of the bone-member layer member that makes contact with an object and/or on its noncontact-surface side opposed to the contact-surface side.

10. A grasping hand having a plurality of finger mechanisms provided in opposition, each of the finger  
15 mechanisms having a multi-joint drive mechanism which

includes a bone-member layer member (101) in which a plurality of bone members (1, 1-1, 1-2, 1-3, 1-4) are arranged in arrays, the plurality of bone members being movably coupled at coupling portions (1A, 1B, 2A, 30), and  
20 elastically expanding/contracting members (3, 3-1, 3-2, 3-3) which are arranged so as to stretch over the coupling

portions on a contact-surface side of the bone-member layer member that makes contact with an object and/or on its noncontact-surface side opposed to the contact-surface side  
25 and moreover which are fixed between the plurality of bone

members, wherein the multi-joint drive mechanism drives flexural motions with the coupling portions between the plurality of adjoining bone members serving as joints by expanding or contracting the elastically expanding/contracting member, and

wherein the grasping hand performs grasping operation for the object by expanding or contracting the elastically expanding/contracting member to drive the finger mechanisms.

10 11. The grasping hand as claimed in Claim 10, wherein the grasping hand is enabled to grasp the object by the plurality of finger mechanisms provided in oppositions and has, at least on a grasping surface side of the grasping hand, touch sensors such as pressure-sensitive sensors or  
15 friction sensors, or displacement sensors for the coupling portions, or tag information detection antennas (8, 9, 13, 42, 46), wherein grasping operation is controlled based on information detected by the sensors or antennas.

12. The grasping hand as claimed in Claim 10 or 11,  
20 wherein at least a part of the grasping surface side of the grasping hand is covered with a high-friction soft material such as rubber.

13. The grasping hand as claimed in Claim 10 or 11,  
wherein the elastically expanding/contracting member is  
25 provided on an outer side-face side of the grasping hand,

the elastically expanding/contracting member including both expansion type and contraction type ones so as to drive the grasping operation by antagonistic action of both types.

14. The grasping hand as claimed in Claim 9 or 11,  
5 wherein a grasping-object information detection device (57) such as an ultrasonic type or image pick-up type or other grasping object detection sensor or camera or a tag information detection antenna is provided at a base portion of the grasping hand, whereby the grasping operation is  
10 controlled based on grasping-object information detected by the grasping-object information detection device.

15. A robot comprising: a grasping hand (50) having a plurality of multi-joint drive mechanisms, each of the multi-joint drive mechanisms having a bone-member layer member (101) in which a plurality of bone members (1, 1-1, 1-2, 1-3, 1-4) are arranged in arrays, the plurality of bone members being movably coupled at coupling portions (1A, 1B, 2A, 30), and elastically expanding/contracting members (3, 3-1, 3-2, 3-3) which are arranged so as to stretch over  
20 the coupling portions on a contact-surface side of the bone-member layer member that makes contact with an object and/or on its noncontact-surface side opposed to the contact-surface side and moreover which are fixed between the plurality of bone members, wherein the multi-joint drive mechanisms drive flexural motions with the coupling  
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portions between the plurality of adjoining bone members serving as joints by expanding or contracting the elastically expanding/contracting member; and

5           a pressure-sensitive sensor, friction sensor or other touch sensor, or a displacement sensor for the coupling portions (8, 9, 13, 42, 46) provided on the grasping hand, whereby grasping operation of the grasping hand is controlled based on information detected by the sensor or antenna.

10         16.       The robot as claimed in Claim 15, further comprising a grasping-object information detection device (57) such as an ultrasonic type or image pick-up type or other grasping object detection sensor or camera or a tag information detection antenna, whereby the grasping 15 operation of the grasping hand is planned and controlled based on grasping-object information detected by the grasping-object information detection device.

20         17.       The multi-joint drive mechanism as claimed in Claim 1, wherein the bone-member layer member has the plurality of bone members arranged in arrays and in a generally planar fashion.